VARIATION IN BEES.

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In the study of evolution, there is nothing more important than the investigation of variations, since the whole doctrine rests upon the premise that organisms do vary. There was a time when it was sufficient in such an investigation to take a series of specimens and from the general looks of things postulate theories. But the world has become more critical now and demands that when a statement is made concerning some phenomenon, exact data accompany the statement. Hence, the statistical study of variation which attempts to exactly measure the variations and correlations of different organs and to set them down in figures which "cannot lie." And here we cannot allow the other proverb which says that figures will prove anything, for figures truthfully handled can only prove the truth. But there is, on the other hand, great danger that, having collected a set of measurements, we make a show of accuracy that will lead us and others astray by reason of careless or insufficient analysis. Such work is most troublesome because of its seeming exactness and the difficulty of detecting errors.

Messrs. Casteel and Phillips, in the December (1903) number of this BULLETIN, have taken up a very interesting and vitally important problem. The comparative variability of the drone and worker bees hits, in a way, at the very root of the variation question. Accordingly, while we lament with the authors the smallness of their series, it seems well worth while to consider a few points about the paper.

In the first place, we have to disagree with the statement that if the variability is "due to chance," it is "not in accordance with any law," for it is well known, and has been for years, that nothing is more bound by law or more expressible in mathematical formulæ than "chance." However, we will heartily agree with them that the "true test of the relative variability" is the "descent in numbers of individuals" in the different classes as they are removed from the mean; but we wonder greatly

why they did not apply this simple test. It is called the standard deviation and must be known to everyone who has ever done any statistical work. The phrases just quoted are taken from the discussion of the counts of the hooks on the hind wings. Let us therefore examine them by means of this confessedly better measure.

We find that for the drones we have:

Lot.	No. of Specimens.	Standard Deviation.	Probable Error.
I.	50	2.1548	0.1453
II.	100	1.5435	0.0736
III.	100	1.7716	0.0845
IV.	100	1.6486	0.0786
V.	50	2.0988	0.1416
VI.	98	1.9377	0.0934

For the workers we have:

Lot.	No. of Specimens.	Standard Deviation.	Probable Error.
I.	50	1.5223	0.1027
II.	350	1.5564	0.0397
III.	100	1.5523	0.0740

This gives an average standard deviation, or variability, for the drones of 1.8592 ± 0.1028; and for the workers of 1.5437 ± 0.0721. But we see that the difference between the averages for the two sexes is less than the difference between the two sets of drones from the same hive (I. and III.); and, considering the probable errors, neither is significant. If we omit the three small series because of their large probable errors, we see that the difference between the variabilities of the two sexes is even smaller and clearly not significant. It is also unfortunate that the work should have been passed by both the authors and still two of the nine averages be wrong. The average for lot II. of the workers is 20.99, not 21.08; and that for lot VI. of the drones is either 22.65 or 22.75, according as we do or do not include the individual with 12 hooks, but it is surely not 22.42. This was probably gotten by including this individual (although he was excluded by their argument above), and then using 100 as the total number, but for some strange reason there are only 99 of the 100 said to have been studied which are listed.

Passing over the grave error of lumping the different series of ratios (p. 27) because they seemed to be alike, when really their only claim to homogeneity is that they are of the same sex and all bees — Italians, hybrids, "peculiar strains," *et al.*, from central Ohio to eastern Pennsylvania being jumbled together — let us take up the first table (vein R) as we have done the last. We find that the standard deviation of lot I. of the workers is 1.5637 ± 0.1055, and for lot V. of the drones — "from the same hive" — is 2.2517 ± 0.1519. There is here a difference of 0.6880. The probable error of this difference is ± 0.1849. The standard deviation of lot I. of drones is 2.4023 ± 0.1620 and that of lot III., of the same sex, also from the same hive is, 2.9598 ± 0.1412. The difference here is 0.5575 ± 0.2149. This is due to the extremely small size of the series measured. Since the formula for the probable error of the standard deviation is 0.6745 (stand. dev./$\sqrt{2n}$), we see how rapidly an increase of "n" — the number of individuals measured — decreases the error of the result. But it is manifest that the differences between the two sexes, as shown by these data are of no significance; for, far within the probable error of our work, we get as great a difference between two lots of drones (one lot being twice as large as either of the two considered in the comparison of the different sexes) as we get between the two sexes.

I have not taken the time to go over the rest of Messrs. Casteel and Phillip's work; but, having reached the above results with the first and the last tables will leave them to go over the intervening ones. It is also probably unnecessary to remark that, even if it turns out that the greater variability of the drones can be established, their proofs of their theory to account for this difference seem rather unsatisfactory.

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